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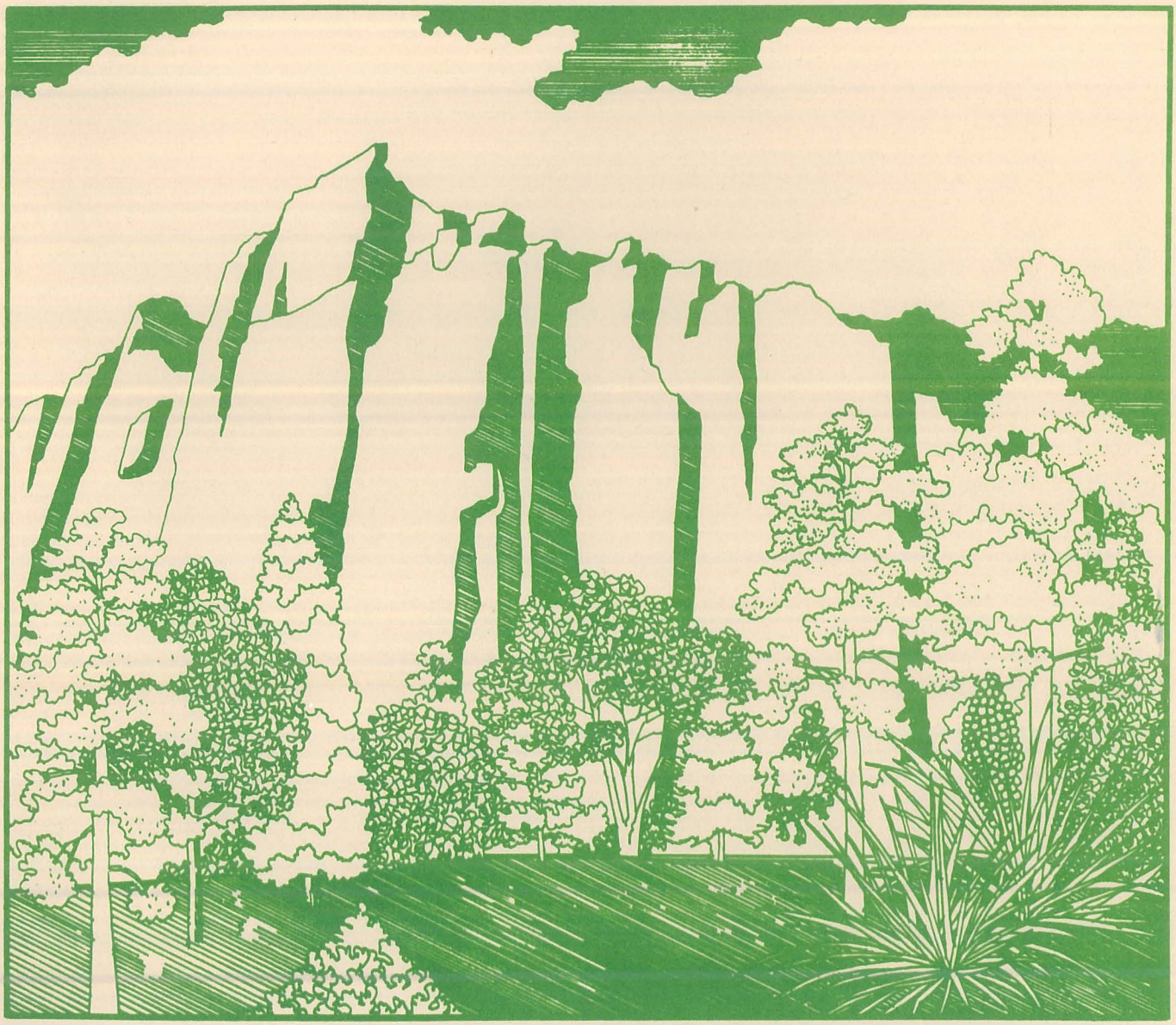
Forest Pest Management Report

R-3 86-3

BIOLOGICAL EVALUATION
Western Spruce Budworm

Carson National Forest
New Mexico

December 1985



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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

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INTRODUCTION

During the last week of July and from mid-August through September 1985, Forest Pest Management personnel conducted a western spruce budworm (WSBW), Choristoneura occidentalis Free., biological evaluation on the Carson National Forest (CNF) and adjoining private lands. This biological evaluation consisted of an aerial sketch-map survey (refer to our 3410 letter of August 23, 1985) and a WSBW egg mass survey. The purpose of this evaluation is to provide forest managers with current information on (1) the extent and severity of budworm defoliation occurring on the CNF and adjoining private lands in 1985 and (2) budworm egg mass densities which provide an indication of larval densities and defoliation trends expected to occur in 1986. Management alternatives and recommendations are also presented.

SUMMARY OF CURRENT OUTBREAK

WSBW defoilation in northern New Mexico was visibly [1] detected on the Questa and Taos entomological units in 1976. New infestations of budworm were next detected on the Tres Piedras and El Rito[2] entomological units in 1982. In 1985, defoliation was detected for the first time on the Penasco entomological unit. Based on aerial insect and disease surveys conducted in 1985, approximately 277,655 acres of susceptible host type were observed defoliated on the CNF, adjoining private lands, and the Taos Indian Pueblo lands. Total acres defoliated in 1985 are summarized by individual ownerships below and by entomological units for the period 1976 through 1985 in table 1.

TECHNICAL INFORMATION

Insect. Western spruce budworm, Choristoneura occidentalis Free.

Hosts. Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco.
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry.

Life History. The WSBW completes one generation each year (Furniss and Carolin 1977)

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Larger larvae	June	On buds, strobile, and foliage
Pupae	July	On foliage
Adults	August	In flight

[1] Visible defoliation based on aerial insect and disease detection surveys.
[2] Formerly included as part of the Tres Piedras entomological unit from 1980 through 1981.

Evidence of Infestation

1. Presence of partially eaten foliage.
2. Immature and/or mature larvae feeding on current year's needles.
3. Current year's shoots webbed together.
4. Trees dying from the top downward after several years of heavy defoliation.

Extent of Current WSBW Outbreak. Defoliation, determined from aerial sketch-map surveys, increased on the CNF, Taos Pueblo Indian lands, and adjoining private ownerships from 238,725 acres in 1984 to 277,655 acres in 1985. Defoliation was categorized as follows: Light, 126,651 acres; moderate, 112,846 acres; and heavy, 38,158 acres. Acres of defoliation are summarized by specific ownership below.

	Defoliation			
	Light	Moderate	Heavy	Total
Carson NF	99,143	104,144	36,316	239,603
Taos Pueblo IR	16,993	6,613	243	23,849
Adjoining private	10,515	2,089	1,598	14,203

The results obtained from the aerial sketch-map survey and WSBW egg mass survey on the CNF and adjoining private lands in 1985 are summarized below by individual entomological units. Predicted defoliation trends are based on 1985 egg mass densities according to McKnight et al. 1970:

Egg mass density [a]	Predicted defoliation class [b]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a] Number of egg masses per square meter of foilage.
[b] Defoliation class limits (percent of new growth).
Undetectable 5 percent
Light = 5 to 35 percent
Moderate 35 to 65 percent damage
Heavy 65 percent

Because of the extended duration of the current outbreak and the severity of defoliation which has already occurred on the CNF, egg mass density estimates may no longer correlate well with predicted defoliation class in areas heavily defoliated for five or more consecutive years. In these areas, even low budworm population levels could cause a significant defoliation and bud damage.

RESULTS AND PREDICTION OF TREND

Questa Entomological Unit. This unit consists of the Questa Ranger District and adjoining private ownerships. Defoliation on the Questa entomological unit increased from 52,700 acres in 1984 to 71,298 acres in 1985. Most of the defoliation observed on this unit was categorized moderate and heavy (figure 1) and occurred throughout the host type in Cabresto, Red River, and Hondo Canyons. Moderate and heavy defoliation also occurred along the west-facing slopes of the Sangre de Cristo Mountains from Latir Creek (northwest portion of the unit) south to Hondo Canyon. Areas showing apparent tree mortality remained at levels similar to those reported in 1984 (R-3 85-3) and were mainly concentrated along the north-facing slopes of State Highway 38 from Eagle Lake east to the township of Red River.

Results from WSBW egg mass surveys conducted on this unit show 1985 budworm mass densities to be at their lowest levels in 8 years (table 1). Average egg mass densities on this unit decreased from 38.5 egg masses per square meter of foliage in 1984 to 6.9 egg masses in 1985, which is over 5 times lower than 1984. Egg mass samples which were obtained from Sawmill Mountain south to the proposed Sangre de Cristo ski area (including Bobcat Pass) and Cabresto and Hondo Canyons averaged 6.7, 9.5, and 4.5, respectively. This lower average density of egg masses indicates that the infestation will decrease sutstantially and the overall infested area will experience undetectable to light defoliation. There will, however, be some stands that will experience moderate defoliation and a few isolated spots of heavy defoliation. Defoliation will be most noticeable from Red River south to the proposed Sangre de Cristo Ski Area.

Taos Entomological Unit. This unit includes the Taos Ranger District, Taos Indian Pueblo lands, and adjoining private ownerships. Defoliation continued to occur throughout most of the host type on this entomological unit in 1985. Defoliation observed, occurred on 89,884 acres and was categorized as light and moderate (figure 2). New areas of defoliation detected for the first time during this outbreak, occurred within the Del Rio Grant along the southern portion of this unit. Budworm-related tree mortality is relatively low on this unit and was mostly confined to the younger age classes.

Budworm egg mass densities on this entomological unit averaged 11.4 egg masses per square meter of foliage. Again, this is a substantial decrease from 1984 levels, which averaged 25.0. Egg mass densities for specific areas sampled are summarized below.

Areas sampled	Egg mass densities/M^2 + S. E.
Capulin Canyon	16.7 ± 3.8
Taos Canyon	7.5 ± 1.0
Valla Escondido Area	17.8 ± 4.6
Palo Flechado Pass*	8.4 ± 1.1
Osha Mountain *	10.9 ± 1.6
Rio Chiquito	8.2 ± 2.6
Rito de La Olla	14.0 ± 3.7
Rio Grande del Rancho	16.9 ± 4.2

* Areas were treated with Bacillus thuringiensis in 1985.

Based on these egg mass survey results, defoliation on the Taos entomological unit is expected to continue throughout most of type in 1986, but it will not be as noticeable as in 1985 and before. Minor topkilling and tree mortality will continue to occur to the younger age classes (seedlings, saplings, and poletimber), particularly in areas that have been severely defoliated for five or more years and where stands are heavily overstocked and infected with tree diseases.

In areas where budworm has just been recently detected (Rio Chiquito, Rito de la Olla, and Rio Grande del Rancho), defoliation is expected to increase in both area and intensity during the next several years.

Defoliation to mixed conifer stands along the eastern boundary of this unit (Palo Flechado Pass south to Osha Mountain) is expected to range from undetectable (≤5 percent defoliation to new growth) to light (> 5 to 35 percent). Budworm infestations in these areas were suppressed with B.t. in 1985.

Tres Piedras Entomological Unit. This unit includes the Tres Piedras Ranger District, the northeast corner of the El Rito Ranger District from State Highway 110 east to Posos Lake (Kiowa Mountain and immediate area), and adjoining private ownerships. Although WSBW infestations on this unit have been suppressed on three separate occassions (1982, 1983, and 1984), treatment efforts have achieved only limited success. Most of the defoliation on this entomological unit in 1985 occurred in areas that were treated with insecticides in 1982 and 1983 (figure 3). Defoliation in areas treated in 1984 was undetectable. Total acres defoliated on this unit in 1985 exceeded 44,852 acres.

Egg mass densities sampled within these areas remained relatively unchanged from 1984 levels (1984--14.7 ± 1.3, 1985--13.2 ± 2.0). Average egg mass densities from specific areas sampled are summarized below.

Areas sampled	Average egg mass densities/M^2 + S. E
Kiowa Mountain[3]	18.7 ± 4.4
La Jara[4,5]	5.0 ± 2.0
Tusas/Willow[3]	25.9 ± 4.5
Maquinita Canyon[3]	7.0 ± 1.8
Duran Canyon[3]	22.4 ± 4.7
Biscara/Martinez (FS 167)[3]	8.2 ± 1.8
Broke Off Mountain (FS 80)[4]	10.3 ± 3.0
Canada Tio Grande[5]	8.8 ± 5.9
Olguin Mesa[5]	13.5 ± 8.7
Los Pinos[5]	11.7 ± 3.1
Hopewell Lake/Burned Mountain[5]	13.0 ± 3.3

[3] Areas treated with a combination of carbaryl and B.t. in 1982.
[4] Areas treated with a combination of carbaryl and B.t. in 1983.
[5] Areas treated with B.t. in 1984.

These results indicate that the budworm will continue to cause defoliation throughout the host type on this unit in 1986 and perhaps longer. Permanent tree damages, however, are not expected to occur for at least a year or two.

El Rito Entomological Unit. This unit includes the El Rito Ranger District and adjoining private lands, excluding Kiowa Mountain. Defoliation on this unit which decreased significantly from 54,000 acres in 1984 to 18,290 acres in 1985, was primarily categorized as light (figure 4). Although egg mass surveys were not conducted on this unit in 1985, defoliation is expected to continue in 1986.

Penasco Entomological Unit. This unit includes the Penasco Ranger District and adjoining private ownerships. Defoliation on this unit was detected on 29,759 acres in 1985. This is the first reported defoliation on this unit in recent years. Areas defoliated were categorized as light and moderate and mainly occurred within the Serna, Santa Fe, and Las Trampas Grant areas, and portions of the Pecos Wilderness (figure 5). Based on egg mass densities collected from 18 trees which averaged 9 egg masses per square meter of foliage,

defoliation could continue to increase on this unit during the next several years.

Canjilon Entomological Unit. This entomological unit consists of the Canjilon Ranger District and adjoining lands of private ownership. Budworm defoliation on the Canjilon entomological unit decreased from 6,950 acres in 1984 to 4,857 in 1985. Defoliation which was categorized as light and moderate (figure 6), occurred from Hidden Lakes south to Lower Canjilon Lakes. Small pockets of defoliation were also detected along the southeast corner of this unit. Defoliation is expected to continue on the unit during the next several years.

Valle Vidal Entomological Unit. This unit includes the Valle Vidal unit which is administered by the Questa Ranger District. Defoliation on this unit increased from 10,300 acres in 1984 to 18,715 acres in 1985. Most of the defoliation observed was categorized as light and moderate (figure 7), and occurred along the Comanche, Bell, Vigil, and Middle Creek drainages. The infestation increased in this unit last year and it is expected to again increase 1986.

MANAGEMENT ALTERNATIVES

Management alternatives available to forest managers for the current WSBW outbreaks consist of primarily two courses of action: (1) No action or (2) suppression with one or a combination of registered pesticides. A discussion of these alternatives follow.

No Action. With this approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: (a) A lack of foilage to maintain a larval population; (b) unfavorable weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. Adverse and beneficial effects of the outbreak would have to be accepted.

These are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative.

Tree damages	Maximum damages (percent)
Growth loss	30
understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree quality loss	90+

2. The costs of this alternative can be considered as the value of the resource damaged. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual quality and economic and social impacts would continue if this alternative were selected.

Direct Suppression. Suppression tactics can be used against the current outbreak. These tactics involve the aerial application of insecticides on (1) the entire infestation, (2) selected entomological units, or (3) high-value stands or groups of stands with the intent of reducing budworm populations and related tree damages. Individual high-value tree protection can be achieved with insecticide applications from the ground.

Aerial applications of insecticides are short-term budworm management techniques, suppressing budworm populations for 3 to 5 years and possibly preventing serious tree damages for a longer period. Insecticide applications are most efficacious when applied to low-density budworm populations (20 larvae per 100 buds) over an entire infestation or entomological unit. At higher budworm population densities or where infestations and entomological units are only partially treated, insecticide applications are less effective. When insecticide applications are targeted at limited areas (stands, scenic corridors, or recreation areas) with high density budworm populations (20 larvae per 100 buds), annual applications will be necessary to achieve treatment benefits.

Applications must be carefully timed to larval development and bud flush; i.e., when 20 percent of the larvae are in the fifth and sixth instars and buds are 85 to 90 percent flushed. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. A direct suppression program can reduce tree damages and losses in the short-term, thus protecting resource values.

2. A direct suppression program will cost $7 to $12 per acre each treatment year dependent upon the program size, application strategy, and insecticides used.

3. Proper use of insecticides will not pose a significant hazard to humans, wildlife, or the environment.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide). The Sevin-4-oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe National Forest, New Mexico, was successfully suppressed in 1977, and the outbreak remained at a low level for over 5 years (Telfer, Ragenovich, and Rogers 1982). Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide). Orthene is a nonpersistent insecticide registered for use against the WSBW and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest against the WSBW.

3. Mexacarbate (carbamate insecticide). Mexacarbate (Zectran) is a nonpersistent pesticide which is available for use against the WSBW. Mexacarbate is applied at a rate of 0.15 pounds of active ingredient per acre. No lasting environmental effects have been identified when properly applied at this rate. In the Southwest, mexacarbate requires additional pilot testing before it can be recommended for operational use.

4. Microbial Insecticides. Bacillus thuringiensis (B.t.), a bacterium, has been used experimentally and operationally in the Southwest. B.t. has adequately reduced WSBW populations, although results are sometimes inconsistent. Foliage protection has generally been poor during the year of application. However, foliage protection the year following treatment has been documented. Continued improvements of B. t. formulations and application techniques have shown promise in increasing the insecticide's efficacy.

RECOMMENDATIONS

1. Long-term Management

The WSBW should be considered a long-term forest management problem and addressed through long range planning. The recommended approach is silvicultural strategies where appropriate which reduce stand susceptibility/ vulnerability. Silvicultural strategies, where they can be implemented, may reduce specific stand vulnerability in the long-term. However, silvicultural strategies will not prevent future outbreaks nor provide relief during current outbreaks. Specific silvicultural prescriptions should include but are not limited to: (1) Intermediate cuttings, such as commercial or precommercial thinning and sanitation/salvage cutting, to increase stand vigor, regulate stocking, and favor nonhost tree species; (2) Regeneration cuttings using clearcut and shelterwood methods designed to create a mosaic of evenage stands with a lower percentage of true fir; and (3) Artifical regeneration with nonhost tree species such as ponderosa pine where appropriate.

2. Short-term management of the current at outbreak.

Questa, Taos, and Penasco Entomological Units.

Direct suppression of all or portions of the Questa and Taos Entomological Units is not recommended from a biological standpoint. The majority of the infestations on these units are in advanced stages and significant tree damages have already occurred. Direct suppression of infestations at this stage of the outbreak cycle would be biologically and economically unsound. This recommendation is also based on the following considerations: (1) infestations have declined substantially; (2) we cannot adequately assure that the available pesticides, especially B. t., can achieve foliage protection during the year of treatment; (3) we cannot adequately assure an effective pesticide application in rough, high elevation areas; and (4) we cannot fully predict the potential for reinvasion of treated areas from adjacent infested areas.

Direct suppression with ground applications of insecticides is recommended for high use, developed recreation areas (campground and picnic areas) where individual trees must be protected from further defoliation to enhance visual quality and esthetics. Specific areas to be treated in 1986 should be evaluated on an individual basis before being treated to ensure budworm population levels are sufficiently high (≥5 larvae per 100 buds) to warrent treatment.

New infestations on the Taos and Penasco Entomological Units should be analyzed for possible management action in 1987, before budworm population densities escalate and permanent tree damages occur. Once budworm populations reach unmanageable levels and permanent tree damages occur, direct suppression may no longer be an acceptable management alternative: In this case, the result would be resource losses plus the cost of treatment.

Tres Piedras Entomological Unit. Recent suppression efforts on the Tres Piedras Entomological Unit have achieved some short-term (1 to 2 years) effectiveness. Portions of this unit were treated over a three year period (1982-1984). Nevertheless, budworm population densities are again at outbreak levels in most of these previously treated areas. Because further large-scale efforts to suppress the outbreak on this unit would, at best, be only marginally successful, direct suppression on this unit is not recommended.

LITERATURE CITED

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McKnight, M. E., J. F. Chansler, D. B. Cahill, and H. W. Flake, Jr. 1970 Sequential Plan for Western Spruce Budworm Egg Mass Surveys in the Central and Southern Rocky Mountains. USDA Forest Service, Res. Note Rm174. 5 p.

Rogers, T. J., and Dayle D. Bennett. 1985. Biological Evaluation Western Spruce Budworm, Carson National Forest, New Mexico. USDA Forest Service, Southwestern Region. R3 853. 18 p.

TABLE 1. Summary of the egg mass and aerial detection surveys on the Questa, Taos, Tres Piedras, El Rito, and Penasco entomological units

Questa entomological unit		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
New egg masses/ square m foliage			9.9	17.9	43.1	47.6	31.3	26.3	16.7	38.5	6.9
Egg mass density ratio			3.4:1	1.7:1	2.4:1	1.1:1	0.7:1	0.8:1	0.6:1	2.3:1	02:1
Actual defoliation[b] (acres)	L	1,900	13,080	2,560	3,174	22,850	4,800	2,025	7,625	625	5,613
	M	300	960	2,330	5,197	15,550	39,700	8,550	1,975	17,750	23,733
	H	0	320	384	6,221	3,275	18,550	36,400	175	34,325	28,134
TOTAL		2,200	14,360	5,274	14,592	41,675	63,050	46,975	9,825	52,700	71,298
Taos entomological unit											
New egg masses/ square m foliage		38.3	22.3	36.3	42.8	50.6	14.1	17.2	26.3	25.0	11.7
Egg mass density ratio[a]		1.7:1	0.6:1	1.6:1	1.2:1	1.2:1	0.3:1	1.2:1	1.5:1	0.9:1	05:1
Actual defoliation[b] (acres)	L	9,400	15,040	2,725	6,477	31,200	6,375	7,125	18,500	15,625	52,452
	M	6,600	10,800	2,790	9,191	26,750	41,125	18,550	6,825	26,550	30,346
	H	560	0	4,250	282	6,975	15,775	3,375	50	31,750	7,086
TOTAL		16,560	25,840	9,765	15,950	64,925	63,275	29,100	25,375	73,925	89,884

TABLE 1. Summary of the egg mass and aerial detection surveys on the Questa, Taos, Tres Piedras, El Rito, and Penasco entomological units--Continued

Tres Piedras entomological unit		1980[c]	1981[d]	1982	1983	1984	1985
New egg masses/square m foliage		1.8	35.0	6.8	22.3	14.7	13.2
Egg mass density ratio [d]			19.4:1	0.2:1	3.3:1	0.6:1	0.9:1
Actual defoliation [b] (acres)	L	550	5,650	2,625	8,800	14,525	25,797
	M	0	50	1,725	9,650	25,725	18,903
	H	0	0	0	50	525	152
TOTAL		500	5,700	4,350	18,500	40,775	44,852
El Rito entomological unit[e]							
New egg masses/square foliage		29.7	33.5	18.6	42.6	20.8	
Egg mass density			1.1:1	0.5:1	2.3:1	0.5:1	
Actual defoliation [b] (acres)	L	325	1,700	20,275	7,225	3,925	15,012
	M	900	1,100	13,075	35,350	26,400	2,775
	H	75	200	600	1,275	23,750	503
TOTAL		1,300	33,950	33,950	43,850	54,075	18,290

TABLE 1. Summary of the egg mass and aerial detection surveys on the Questa, Taos, Tres Piedras, El Rito, and Penasco entomological units--Continued

Penasco entomological unit		1985
New egg masses/square^{m} foliage		9.0
Egg mass density ratio [a]		
Actual defoliation[b] (acres)	L	19,972
	M	8,892
	H	895
TOTAL		29,759

[a] Egg mass density ratio is the ratio of new egg masses in the survey year to new egg masses of the previous year.
[b] Actual defoliation as determined from aerial detection survey; L = light, M = moderate, H = heavy.
[c] Data obtained from report R-3 81-4.
[d] Data previously combined under Tres Piedras entomological unit in 1981.
[e] Egg mass survey not conducted on this unit in 1985.

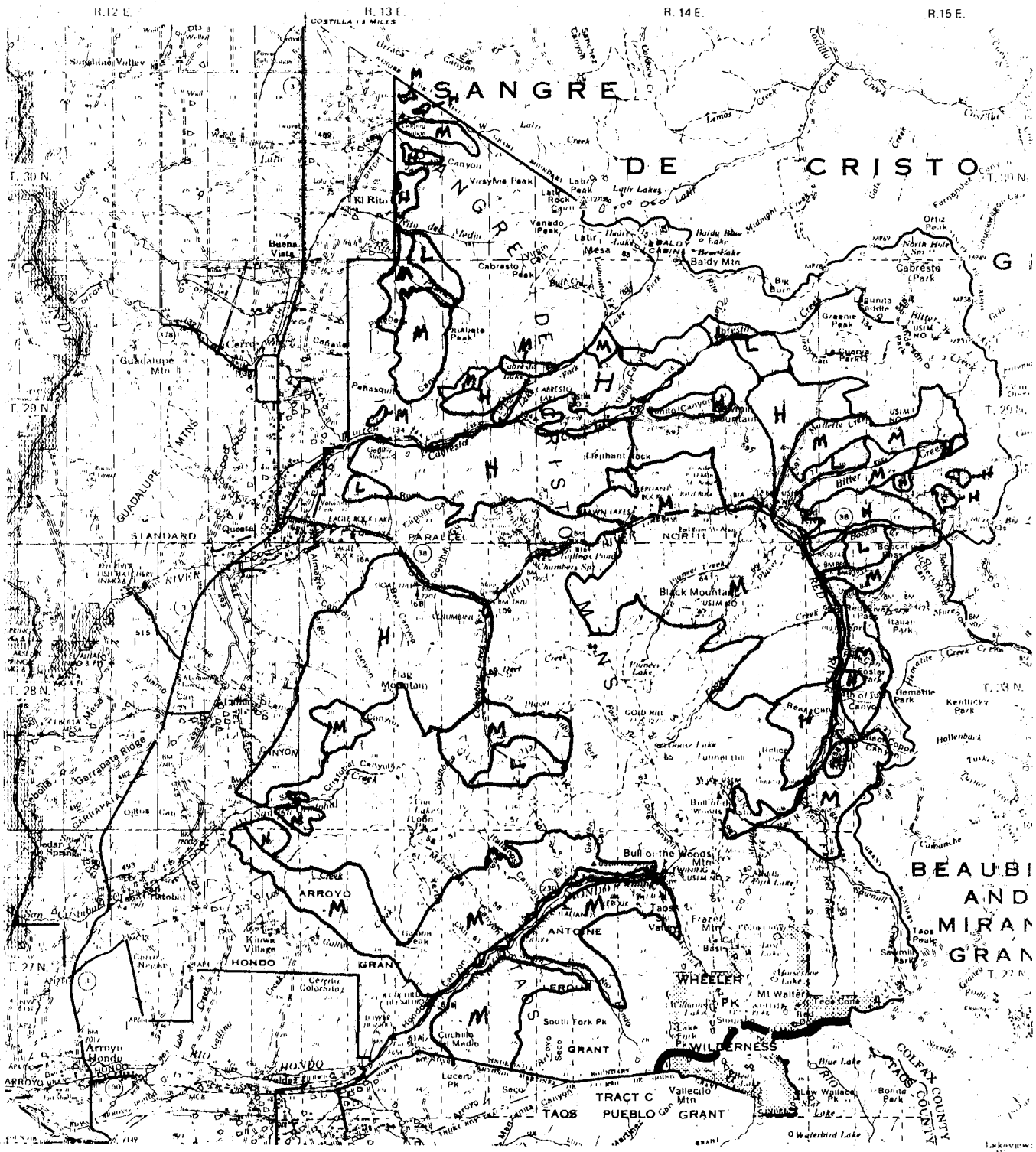

FIGURE 1. Extent of western spruce budworm defoliation, Questa entomological unit, 1985

L = Light; M = Moderate; H = Heavy

QUESTA RANGER DISTRICT

CARSON NATIONAL FOREST

NEW MEXICO

1977

Scale

1 1/2 0 1 2 3 4 5 Miles

LEGEND

Ranger District Boundary

National Forest Land

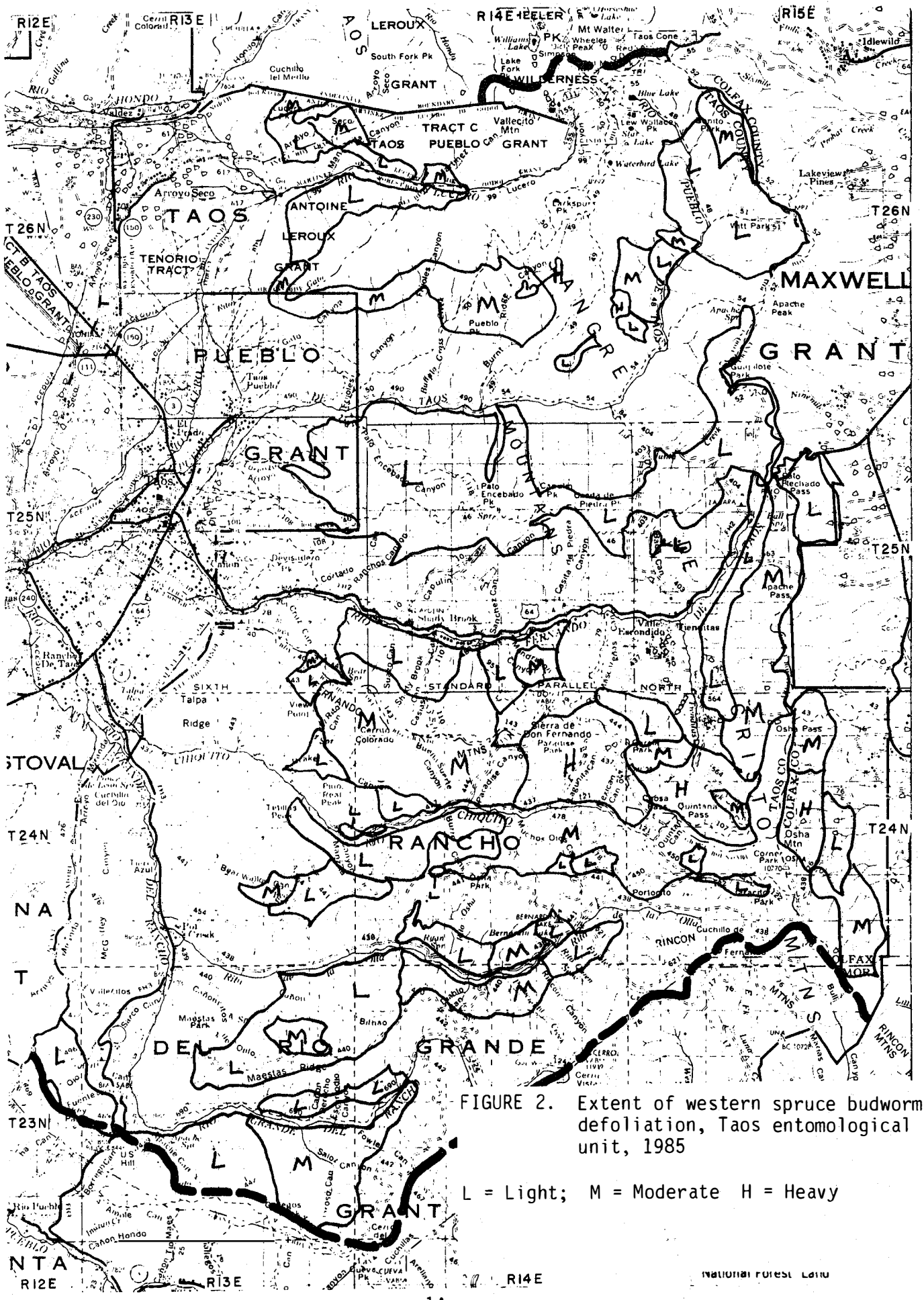

FIGURE 2. Extent of western spruce budworm defoliation, Taos entomological unit, 1985

L = Light; M = Moderate H = Heavy

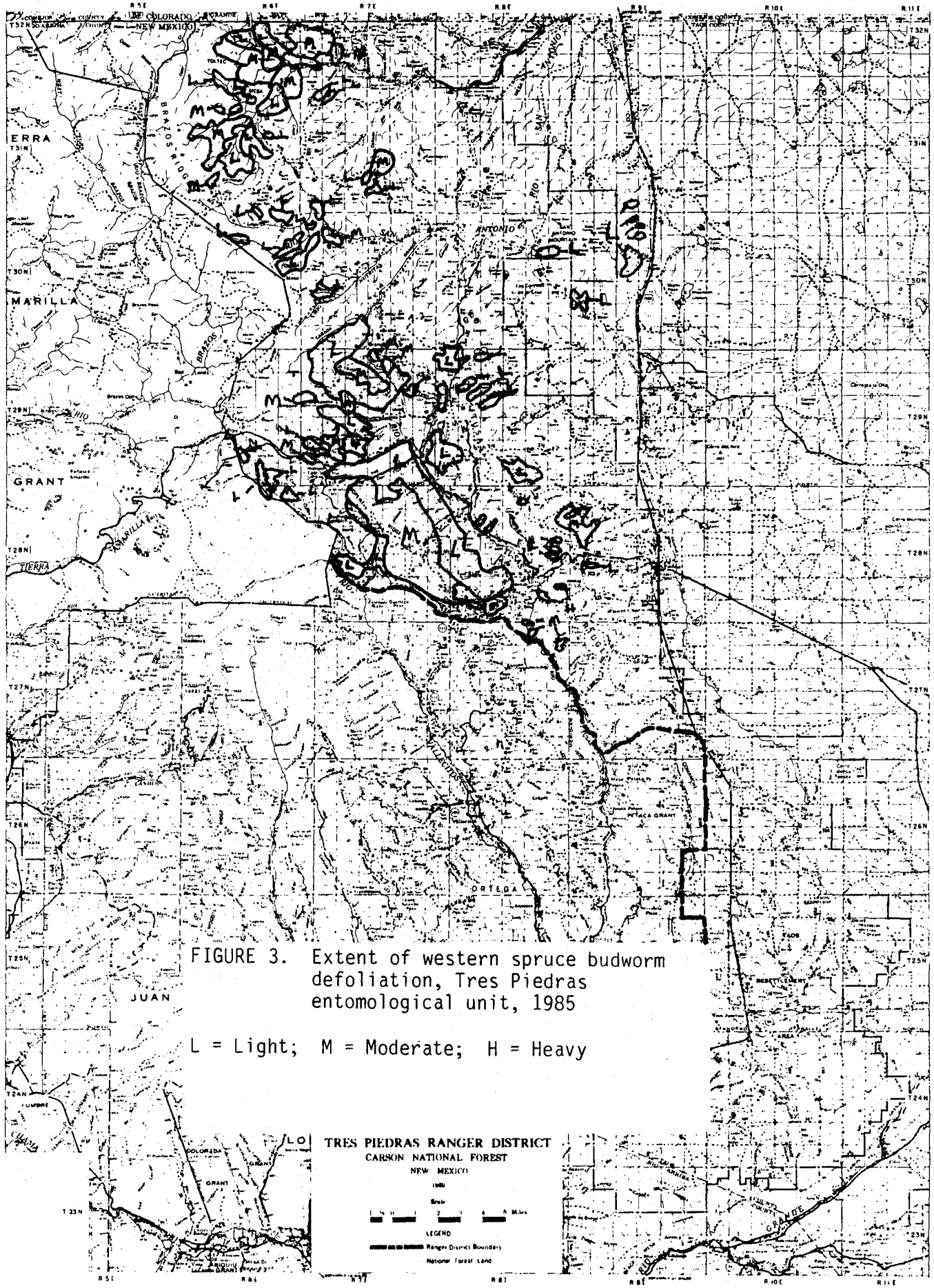

FIGURE 3. Extent of western spruce budworm defoliation, Tres Piedras entomological unit, 1985

L = Light; M = Moderate; H = Heavy

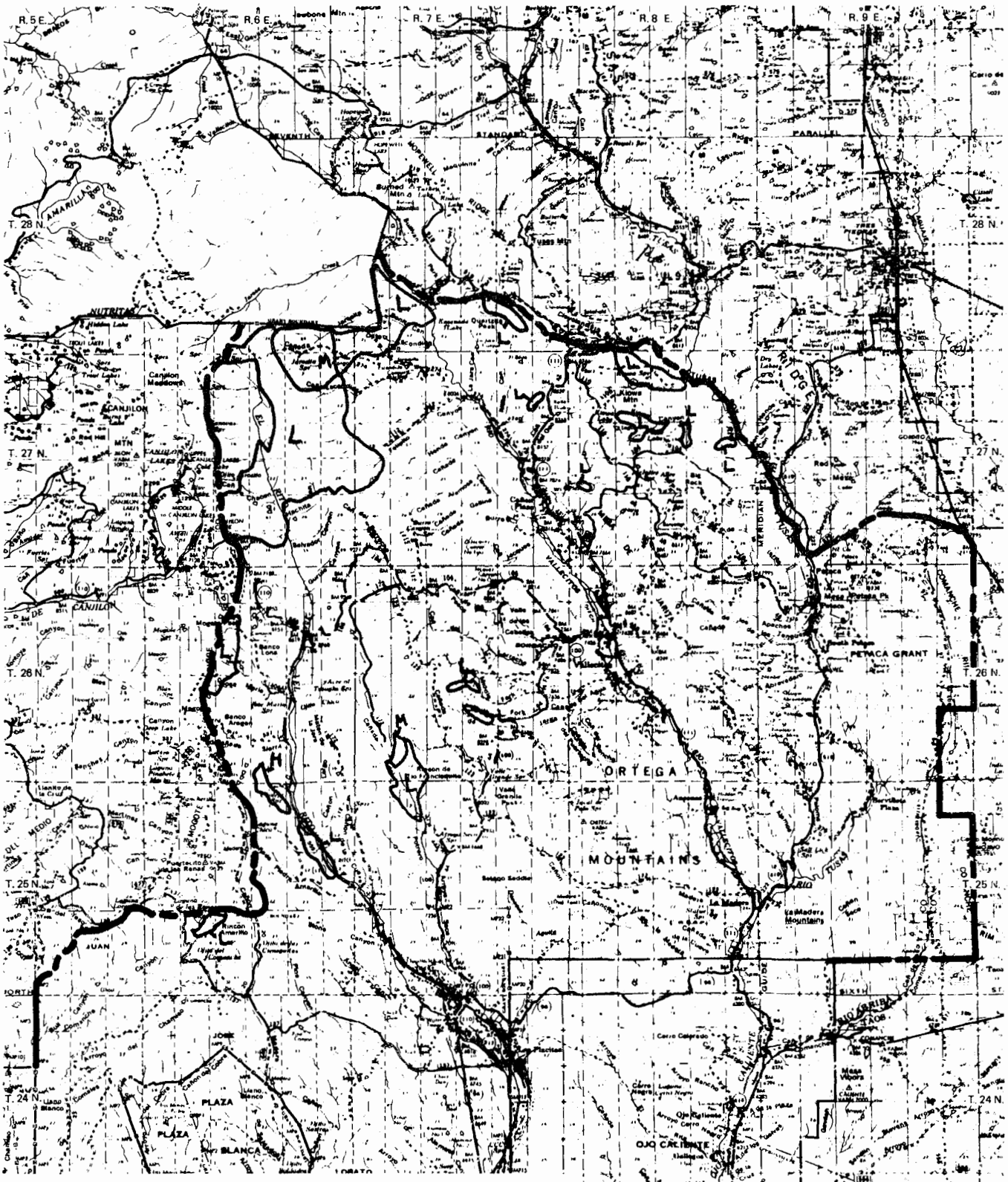

FIGURE 4. Extent of western spruce budworm defoliation, El Rito entomological unit, 1985

L = Light; M = Moderate; H = Heavy

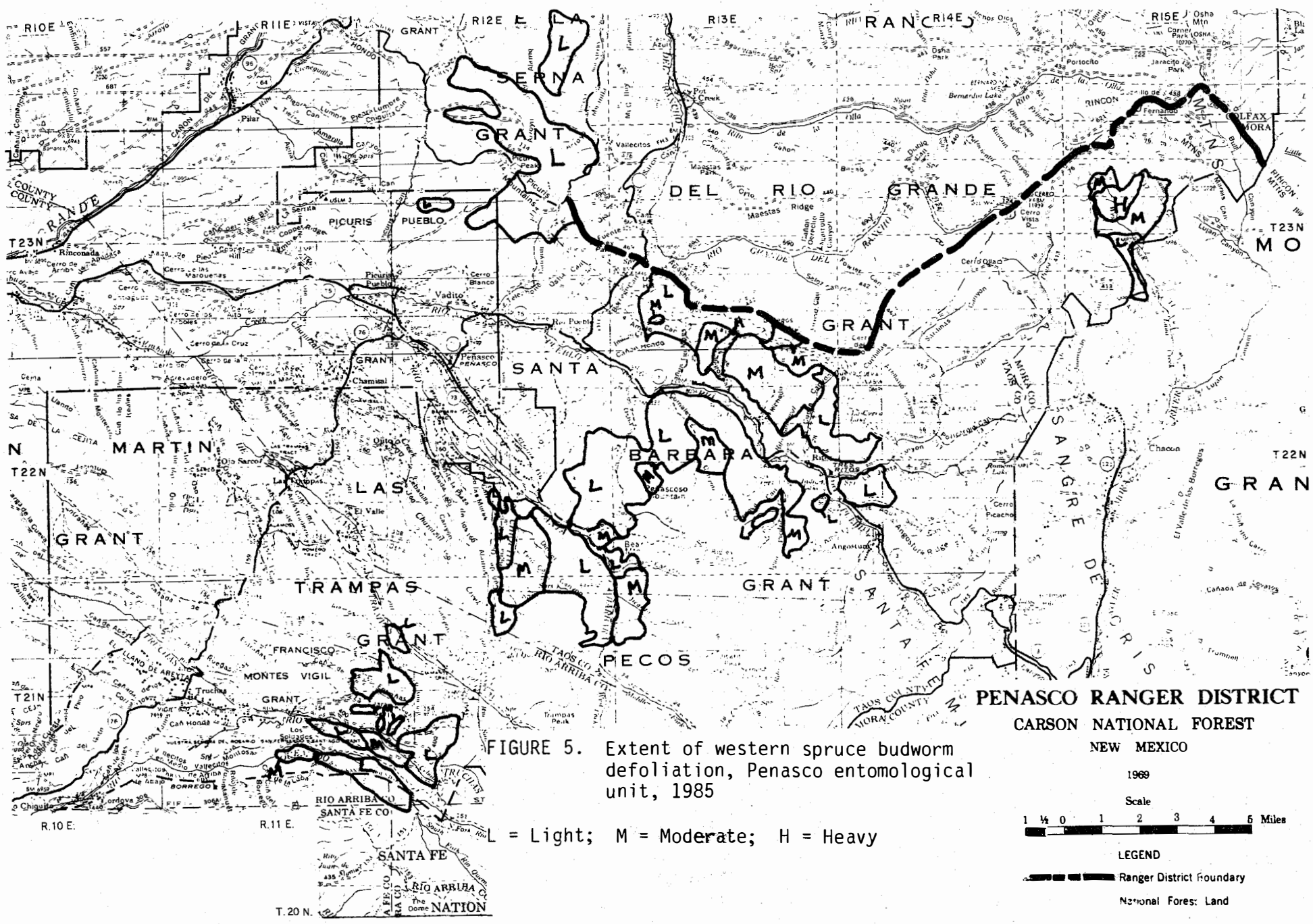

FIGURE 5. Extent of western spruce budworm defoliation, Penasco entomological unit, 1985

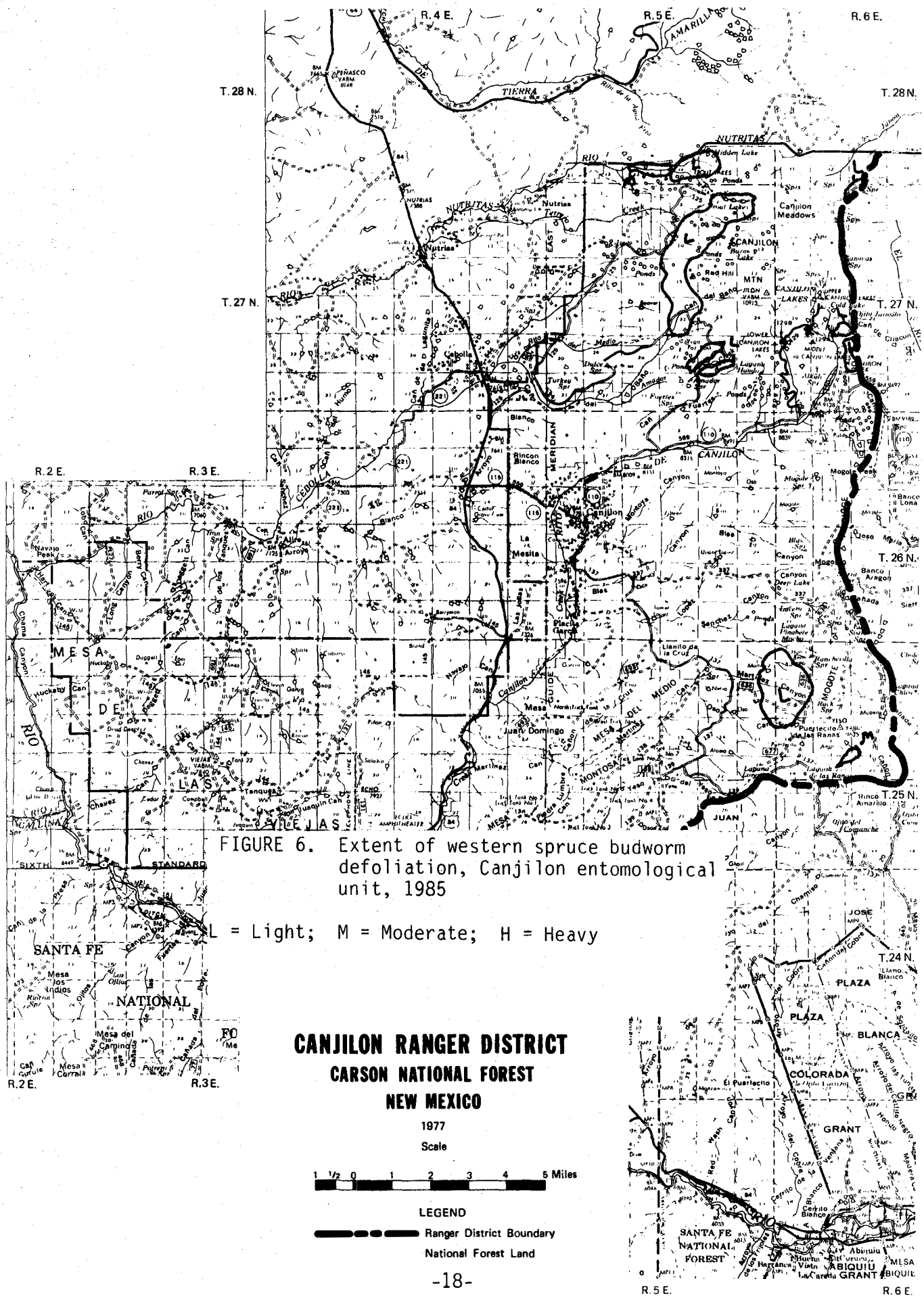

FIGURE 6. Extent of western spruce budworm defoliation, Canjilon entomological unit, 1985

L = Light; M = Moderate; H = Heavy

CANJILON RANGER DISTRICT

CARSON NATIONAL FOREST

NEW MEXICO

1977

Scale

1 1/2 0 1 2 3 4 5 Miles

LEGEND

Ranger District Boundary

National Forest Land

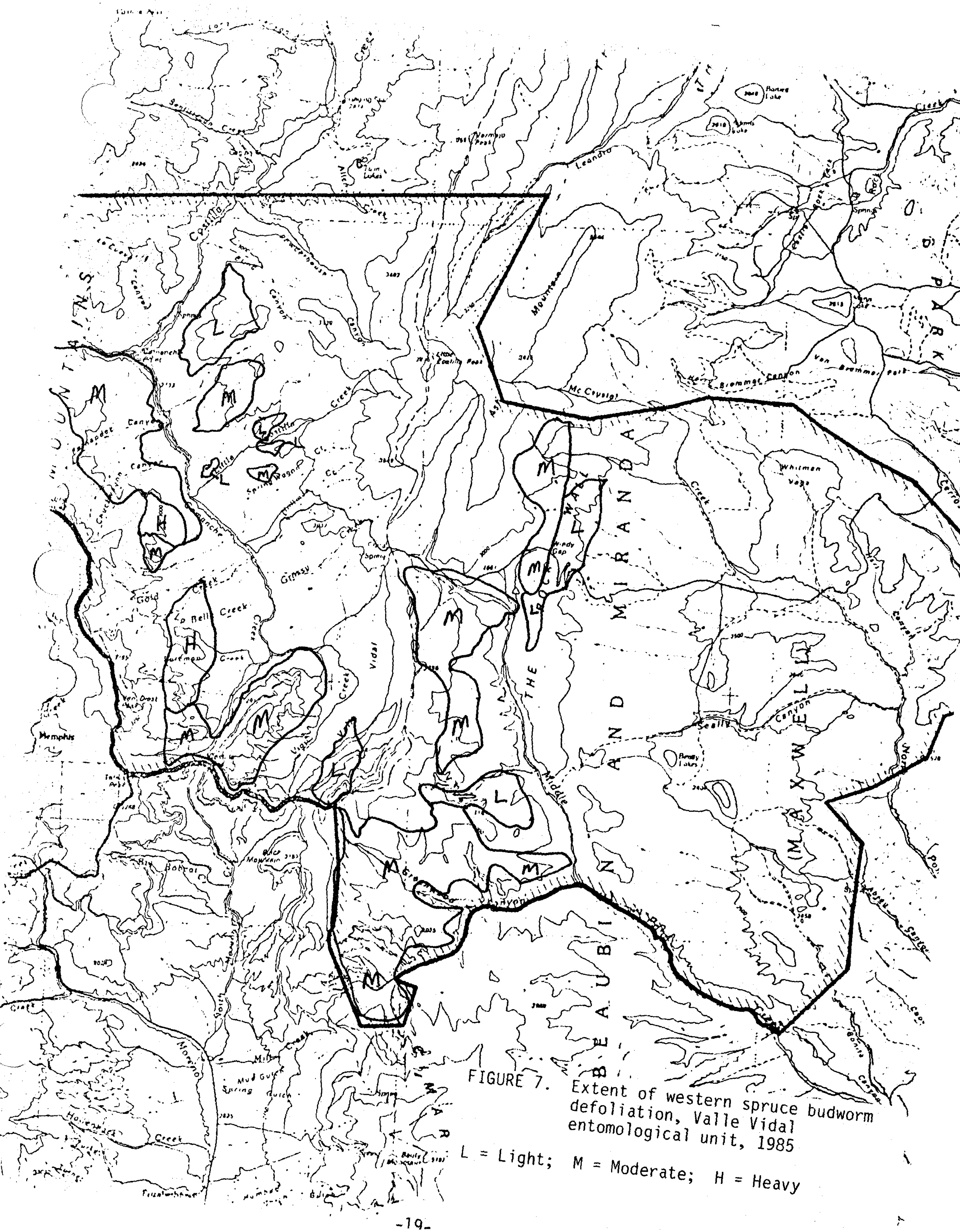

FIGURE 7. Extent of western spruce budworm defoliation, Valle Vidal entomological unit, 1985

L = Light; M = Moderate; H = Heavy